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RADIATIVE EVENTS IN DIS OF UNPOLARIZED ELECTRON BY TENSOR POLARIZED DEUTERON. RADIATIVE CORRECTIONS.

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One of the main objective of the HERA experiments is determination of structure functions (SF) of the nucleons over broad range of the kinematic variables. For some purposes it is necessary to measure the deep–inelastic scattering (DIS) cross section at different energies but running the collider at reduced beam energies increases some systematic errors. To solve this problem it was suggested to use the radiative events [1].

To extract information on the neutron spin–dependent SF, $g_1(x)$ polarized deuterons are used. However, the polarized deuteron is interesting in its own, because it has spin one: there are additional spin–dependent SF (caused by deuteron tensor polarization) [2].

The spin–dependent part of the DIS of unpolarized electron beam from the tensor polarized deuteron target was calculated, which is accompanied by emission of the collinear hard photon ($\theta_\gamma = \widehat{\mathbf{p_1 k}} \leq \theta_0,\ \theta_0 \ll 1$),

$$e^-(p_1) + d^T(p) \to e^-(p_2) + \gamma(k) + X, \tag{1}$$

(the spin–independent part of the DIS cross section with tagged photon has been estimated in Ref. [3]).

In the Born approximation the DIS cross section of the process (1) can be written as

$$\frac{z}{y}\frac{d\sigma^B}{dxdydz} = \frac{2\pi\alpha^2(\hat{Q}^2)}{\hat{y}^2\hat{Q}^4}\frac{\alpha}{2\pi}P(z,L_0)[S_{ll}Q_{ll} + S_{tt}(Q_{tt} - Q_{nn}) + S_{lt}Q_{lt}], \tag{2}$$

where $x = \dfrac{Q^2}{2p(p_1 - p_2)}$, $y = \dfrac{2p(p_1 - p_2)}{V}$, $V = 2pp_1$, $\hat{Q}^2 = zQ^2$. The variable $z = 2p(p_1 - k)/V$ is the energy fraction of the electron after the initial state radiation of a collinear photon. The function $P(z, L_o)$ has the following form

$$P(z, L_0) = \frac{1+z^2}{1-z}L_0 - \frac{2z}{1-z}\ , \quad L_0 = \ln\frac{E_1^2\theta_0^2}{m^2}, \tag{3}$$

where m is the electron mass, E_1 is the electron beam energy. The functions S_{ik} $(i, k = l, t, n)$ depend, in the general, on four tensor SF's b_1, b_2, b_3, b_4 and on the kinematical variables also [4]. The quantities Q_{ll}, Q_{tt} and Q_{nn} are the components of the deuteron quadrupole polarization tensor in the laboratory system, where the l axis is directed along the electron beam momentum, the t axis is perpendicular to the l axis and lies in the reaction plane, and the n axis is ortogonal to the reaction plane. The components obey the relations $Q_{ij} = Q_{ji}$ and $Q_{ll} + Q_{tt} + Q_{nn} = 0$. To give an idea of the magnitude of the quantities S_{ik} we calculate them neglecting the high–twist b_3 and b_4 functions and suppose the relation $b_2 = 2xb_1$.

We present in Fig.1 the behavior of S_{ll} and S_{tt} as function of y variable (at fixed x and z variables) for the parametrization of SF b_1 given in Ref. [5].

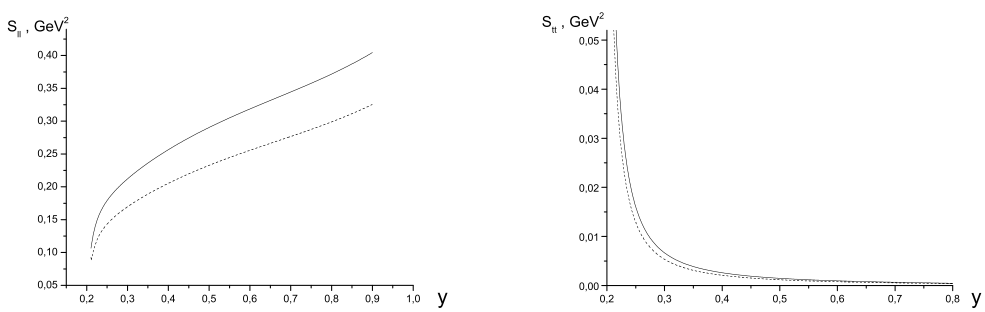

Figure 1: *y–dependence of the quantities $\hat{S}_{ll}$, $\hat{S}_{tt}$ for $x = 0.1$ and $z = 0.82$ (this choice corresponds to the photon energy of 5 GeV, the beam energy is 27.6 GeV). The solid and dash lines correspond to the Paris and Bonn potentials for deuteron wave functions, respectively.*

We have also calculated QED radiative corrections (RC) to the process (1) [4]. The differential cross section of the reaction (1), taking into account QED RC, can be written as

$$\frac{d\sigma}{dxdydz} = \frac{d\sigma^B}{dxdydz}(1+\delta), \tag{4}$$

where δ–term is determined by RC. We calculated RC for the cases of the exclusive and calorimeter event selections [4]. y–dependence of the Born cross section and δ

(under the calorimeter event selection, for $\theta_0 = 0.5 mrad$, $\theta' = 50 mrad$) is shown in Fig.2 for the same kinematical conditions as in Fig.1. For the polarization state of the target we used the target parameters of the Ref. [6]. The tensor polarization of the deuteron target is determined by the quantity $T = 1 - 3n_0$, where n_0 is the atomic population with zero spin projection onto the quantization axis. We consider the case when the quantization axis is directed along the momentum of the initial electron.

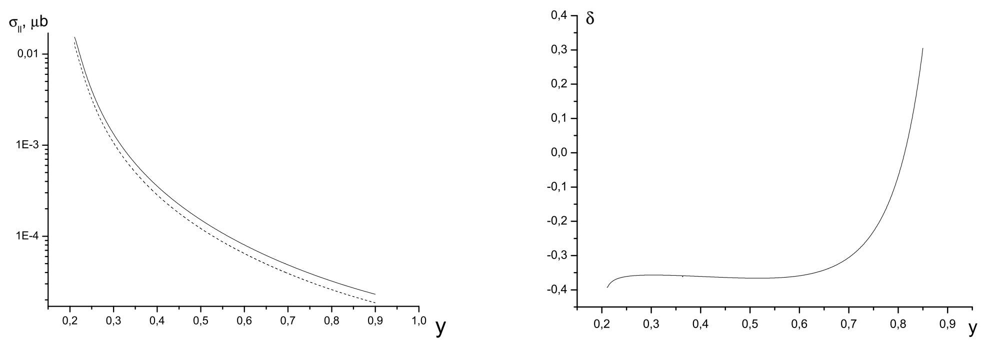

Figure 2: *y–dependence of the cross section (2) (the left figure) and the quantity δ (the right figure) in the case of the longitudinal polarization for the target polarization* $T = 0.83$ *[6]. The rest notations are the same as Fig.1*

1 Acknowledgements

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References

1. M.W. Krasny *et al*, Z. Phys. **C53**, 687 (1992).

2. P. Hoodbhoy *et al*, Nucl. Phys. **B312**, 571 (1989).

3. H. Anlauf *et al*, hep-ph/9805384.

4. G.I. Gakh *et al*, Ukr. Fiz. Gh. **47** 637 (2002).

5. J. Edelmann *et al*, Phys. Rev. **C57** 3392 (1998).

6. M. Contalbrigo, hep-ex/0211014.